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Osthelder et al.

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(54) **SYSTEM AND METHOD FOR CONTROLLING EXHAUST FLOW FROM AN INTERNAL COMBUSTION ENGINE**

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CPC B63H 20/245; B63H 21/32; B63H 20/02; F01N 13/082; F01N 2590/021; F02M 35/167
See application file for complete search history.

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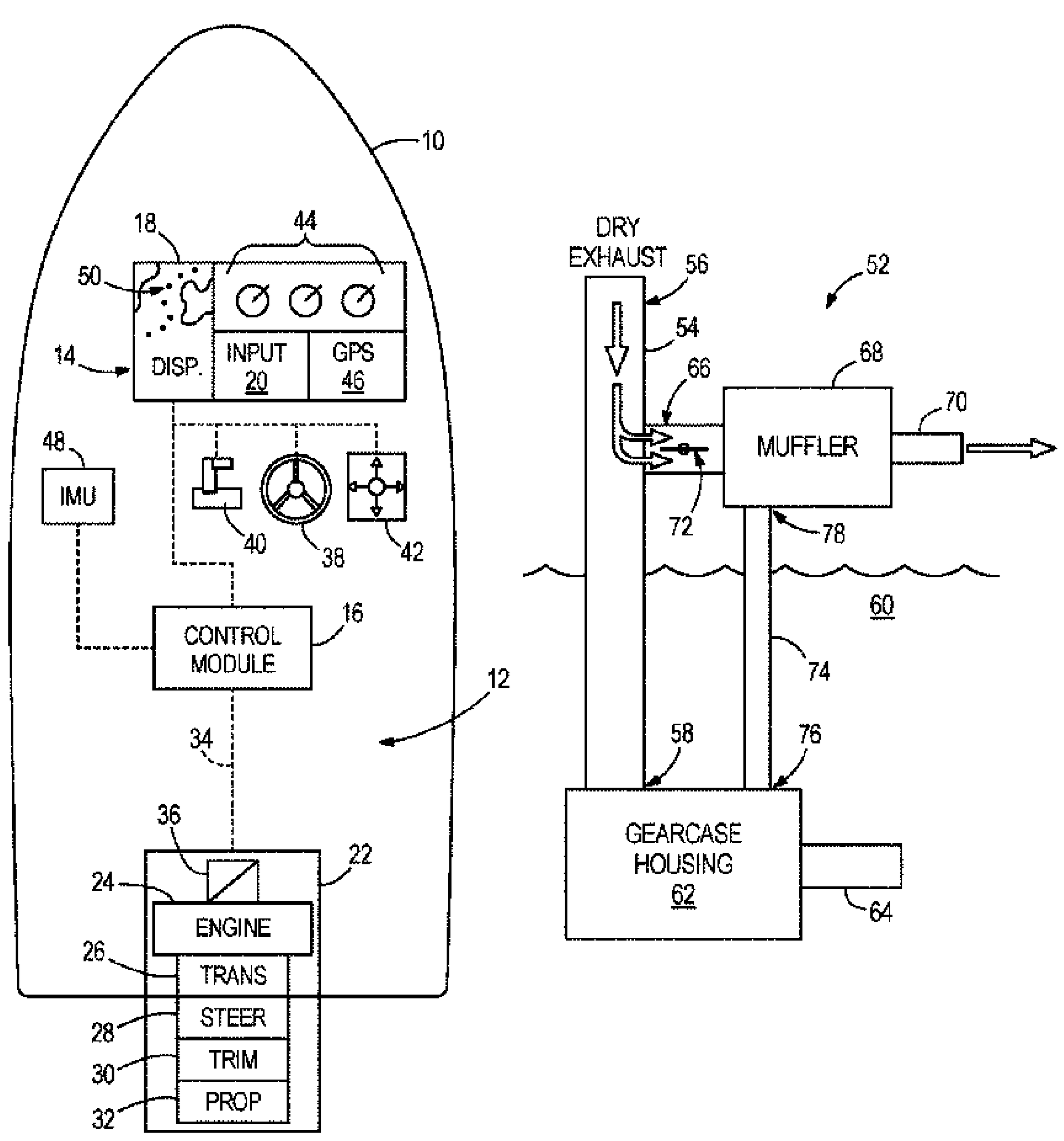
(57) **ABSTRACT**

A system for controlling exhaust flow from an internal combustion engine powering a marine propulsion device includes a primary exhaust conduit having an upstream end receiving exhaust gas from the internal combustion engine and a downstream end discharging exhaust gas to a body of water via a gearcase housing. A bypass exhaust conduit has an upstream end receiving exhaust gas from the primary exhaust conduit and a downstream end discharging exhaust gas from a bypass outlet of the marine propulsion device. A bypass valve is selectively openable to allow exhaust gas to flow through the bypass conduit. A control module is in signal communication with the bypass valve. The control module opens the bypass valve to divert the exhaust gas through the bypass conduit and out the bypass outlet in response to selection of a control mode of the marine propulsion device other than a default lever control mode.

10 Claims, 6 Drawing Sheets



(51) **Int. Cl.**
B63H 21/34 (2006.01)
B63H 20/26 (2006.01)

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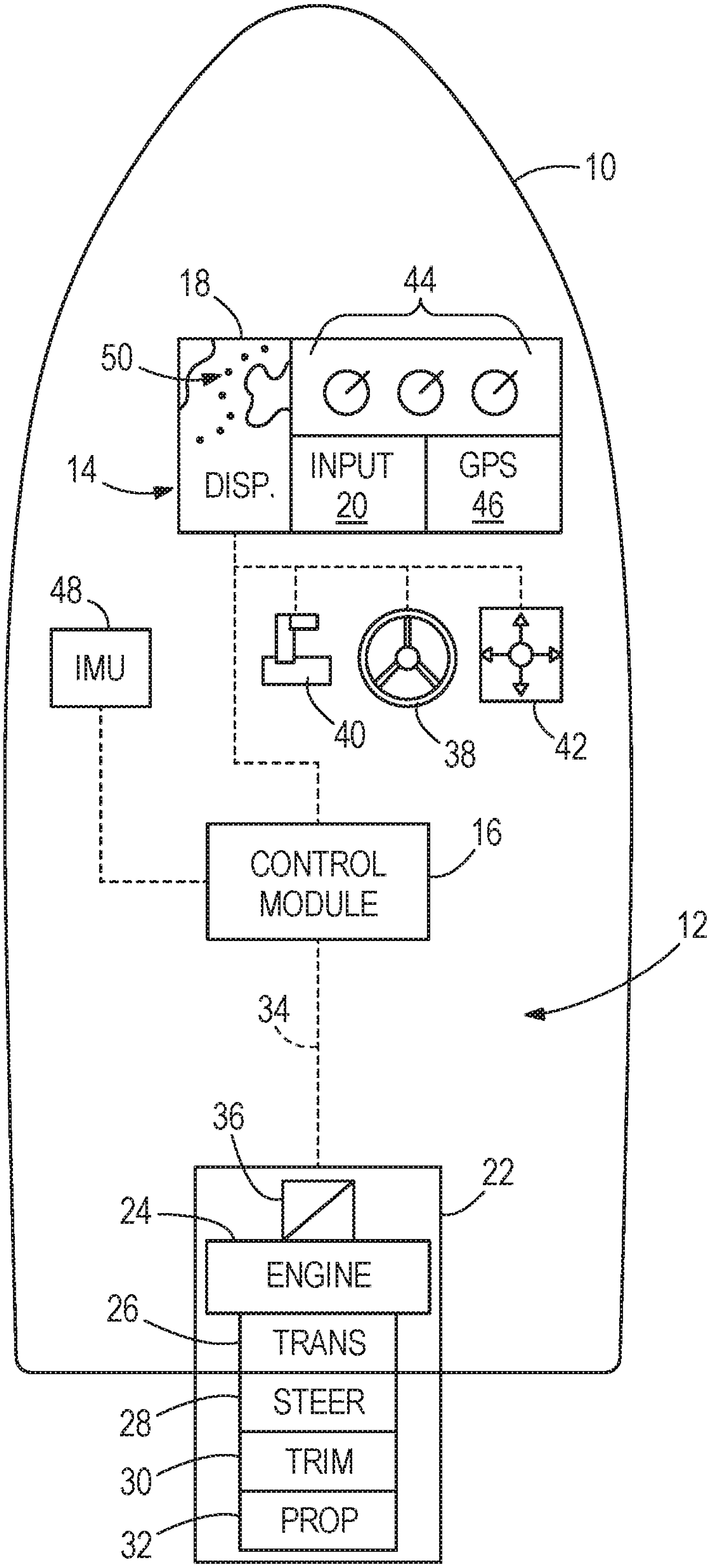
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DISP.
INPUT
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IMU
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CONTROL
MODULE
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TRIM
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PROP
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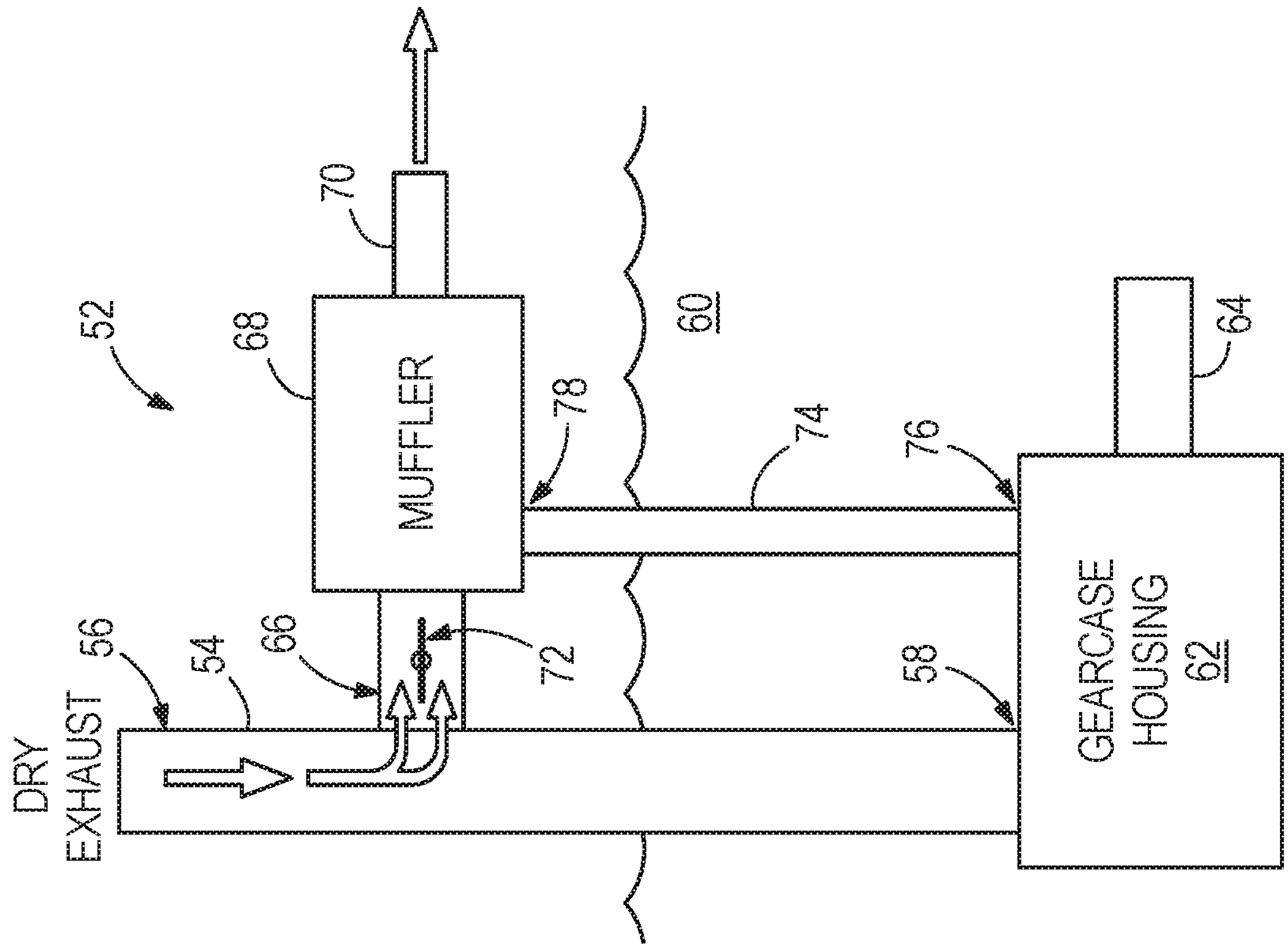
FIG. 1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DRY EXHAUST
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MUFFLER
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GEARCASE HOUSING 62
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FIG. 3

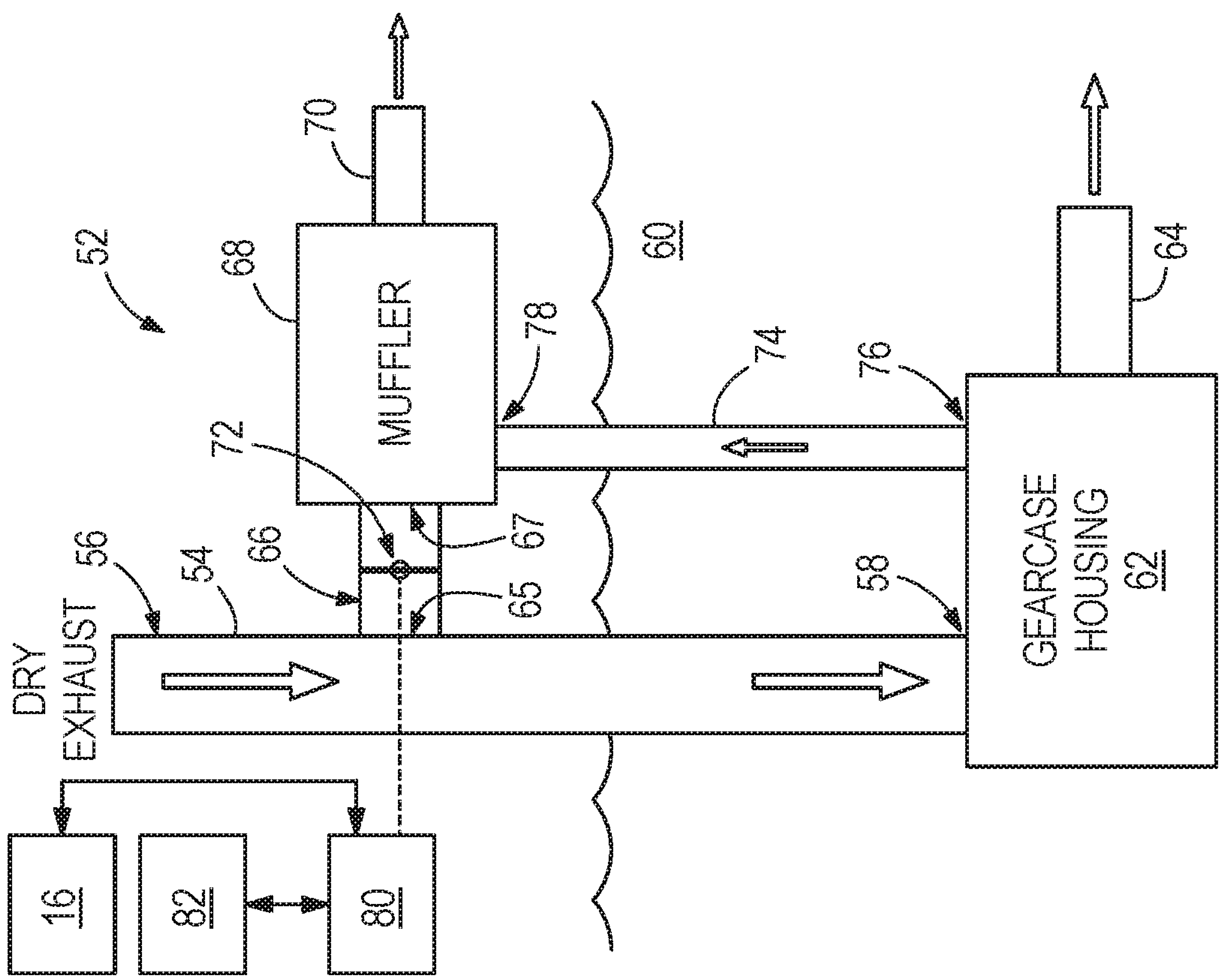
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FIG. 2

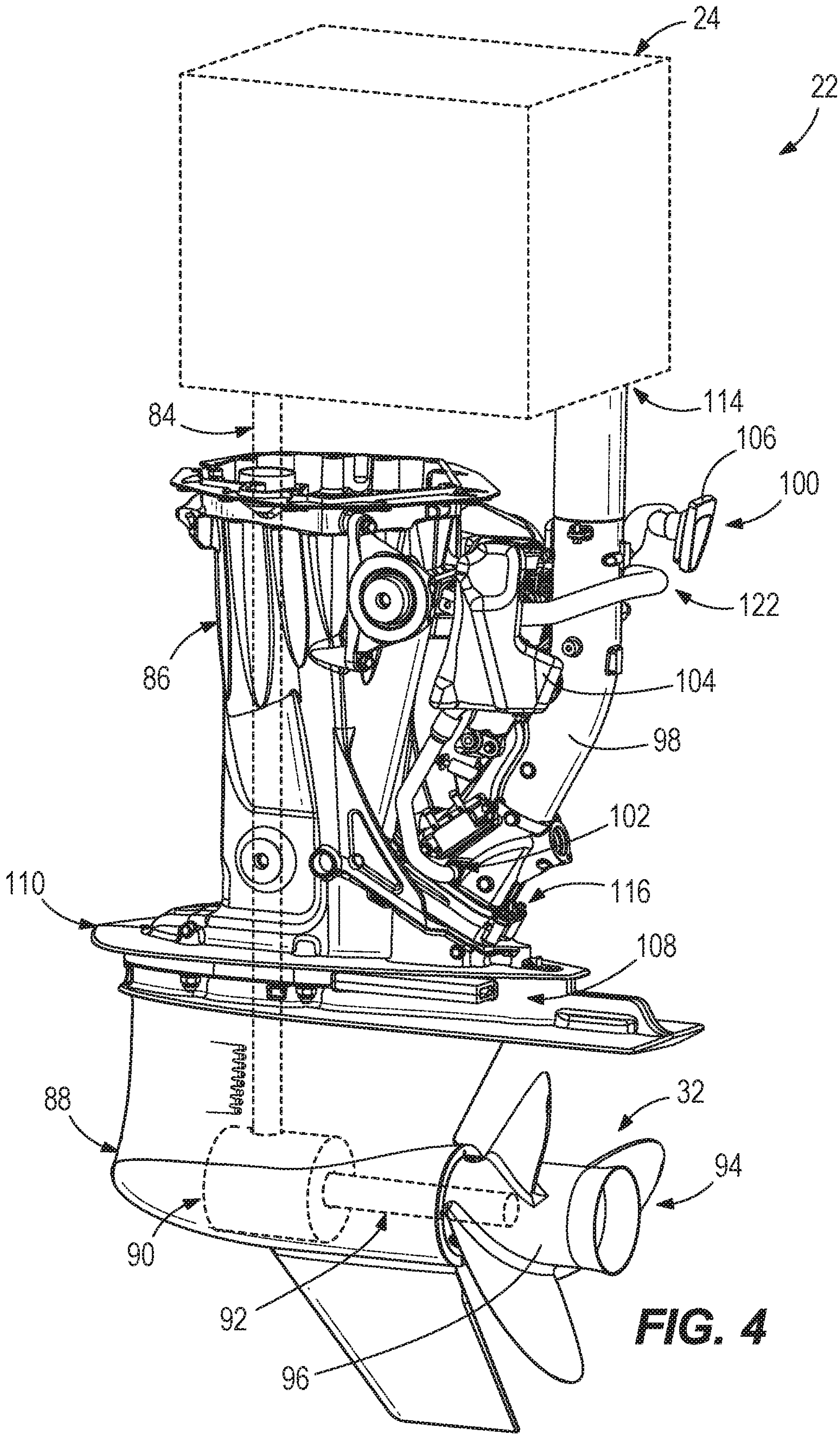

FIG. 4

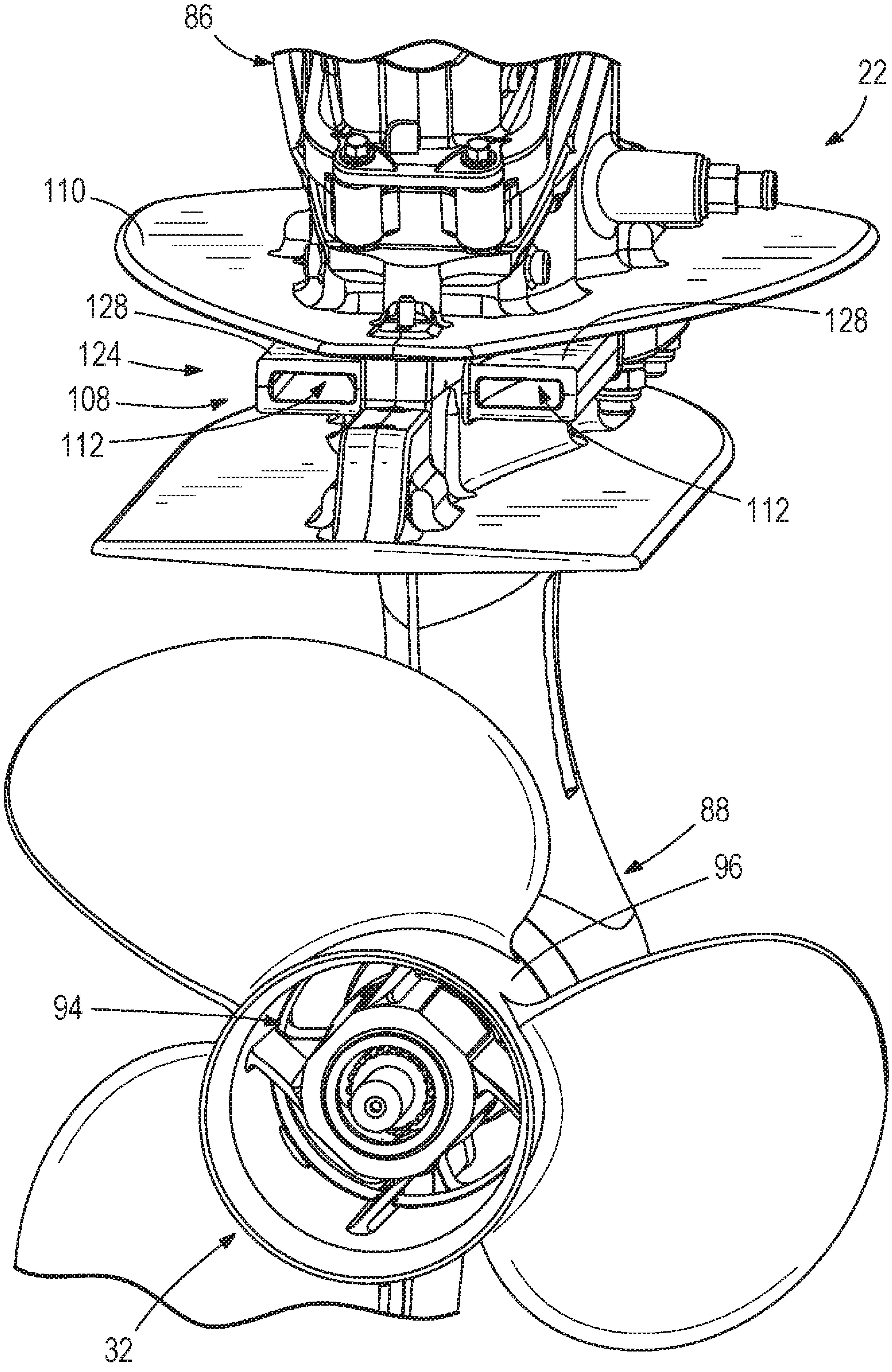

FIG. 5

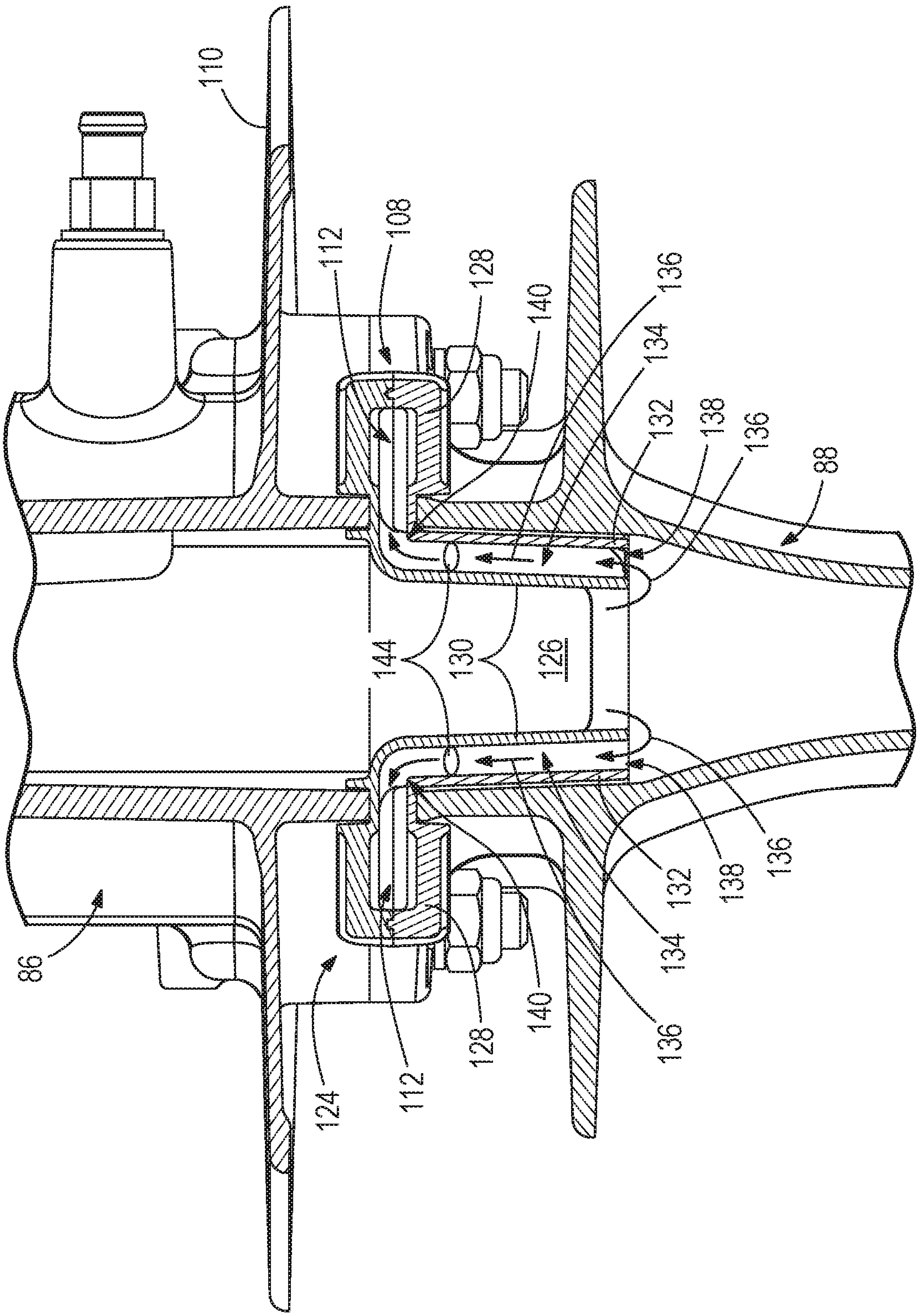
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FIG. 6

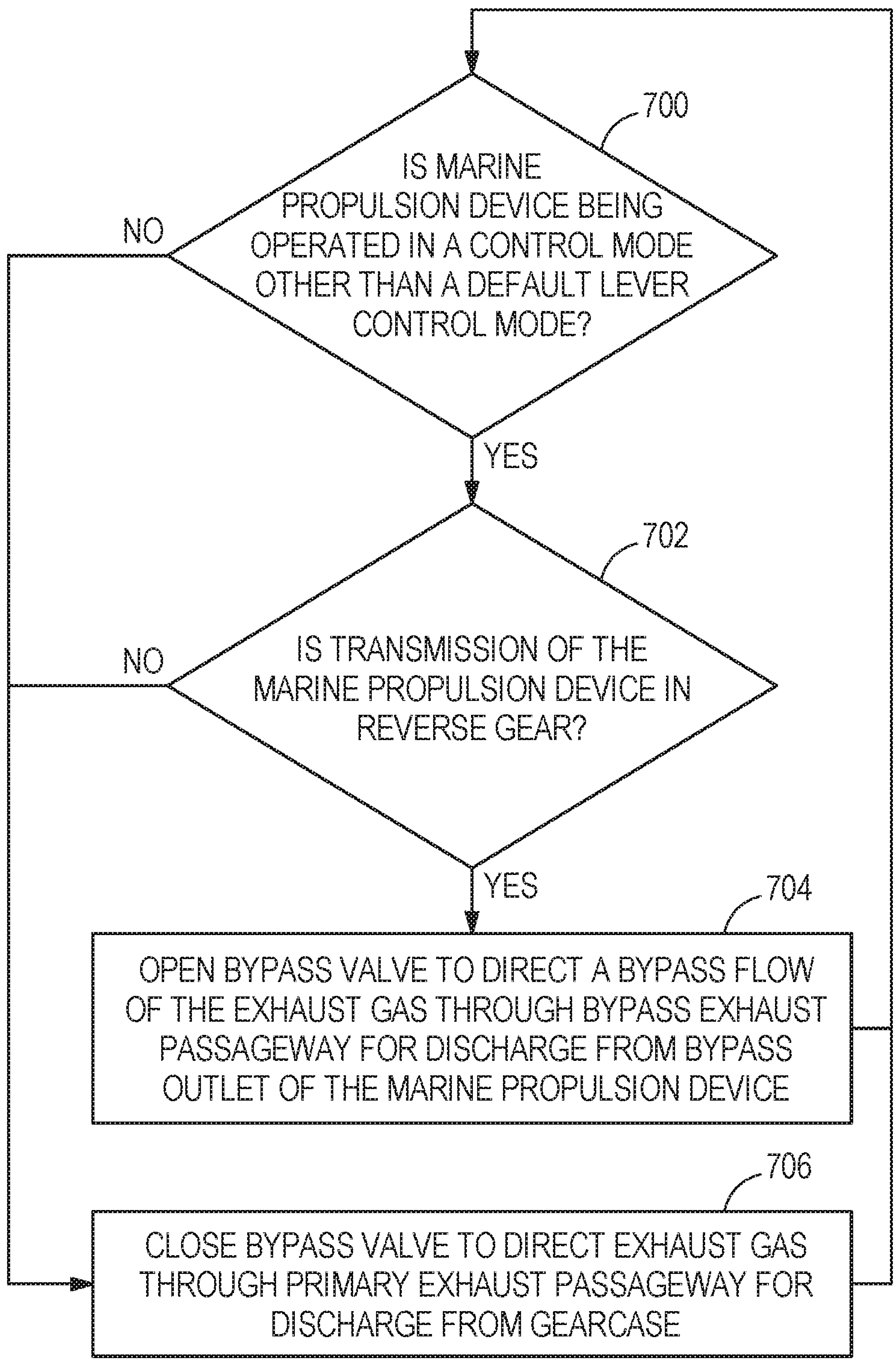
700
IS MARINE PROPULSION DEVICE BEING OPERATED IN A CONTROL MODE OTHER THAN A DEFAULT LEVER CONTROL MODE?
NO
YES
702
IS TRANSMISSION OF THE MARINE PROPULSION DEVICE IN REVERSE GEAR?
NO
YES
704
OPEN BYPASS VALVE TO DIRECT A BYPASS FLOW OF THE EXHAUST GAS THROUGH BYPASS EXHAUST PASSAGEWAY FOR DISCHARGE FROM BYPASS OUTLET OF THE MARINE PROPULSION DEVICE
706
CLOSE BYPASS VALVE TO DIRECT EXHAUST GAS THROUGH PRIMARY EXHAUST PASSAGEWAY FOR DISCHARGE FROM GEARCASE

FIG. 7

SYSTEM AND METHOD FOR CONTROLLING EXHAUST FLOW FROM AN INTERNAL COMBUSTION ENGINE

FIELD

The present disclosure relates to exhaust systems for internal combustion engines of marine propulsion devices and to methods for controlling flow of exhaust gas through such systems.

BACKGROUND

U.S. Pat. No. 3,871,324 discloses an engine-driven outboard propulsion unit having a reversible propeller to selectively drive the propulsion unit in forward and reverse directions and passage means for conducting the exhaust gases from the engine through said unit, a pair of underwater discharge openings for said propulsion unit and respectively disposed fore and aft of the propeller to provide for selective exhaust discharge into the outflow of the propeller slipstream regardless of the direction of propulsion unit operation and thereby assure a solid flow of water to the propeller in both forward and reverse directions of operation of the propulsion unit.

U.S. Pat. No. 8,998,663 discloses an outboard motor and a method of making an outboard motor including providing an exhaust conduit having a first end that receives exhaust gas from an internal combustion engine and a second end that discharges exhaust gas to seawater via a propeller shaft housing outlet. An exhaust conduit opening is formed in the exhaust conduit between the first and second ends. The exhaust conduit opening is for discharging exhaust gas from the exhaust conduit to atmosphere via a driveshaft housing of the outboard motor and via an idle exhaust relief outlet and a driveshaft housing outlet in the driveshaft housing. The driveshaft housing outlet is vertically located between the propeller shaft housing outlet and the idle exhaust relief outlet. A cooling pump pumps cooling water from a cooling water inlet for cooling the internal combustion engine to a cooling water outlet for discharging cooling water from the outboard motor. The exhaust conduit opening and cooling water outlet are configured such that the cooling water collects by gravity in the driveshaft housing to a level that is above the exhaust conduit opening.

U.S. Pat. No. 9,944,376 discloses exhaust systems for outboard marine engines that are configured to propel a marine vessel in a body of water. An intermediate exhaust conduit is configured to receive the exhaust gas from the primary exhaust conduit. A primary muffler receives the exhaust gas from an intermediate exhaust conduit. A secondary muffler receives the exhaust gas from the primary muffler. An idle relief outlet discharges the exhaust gas from the secondary muffler to atmosphere. A bypass valve is positionable into an open position wherein the exhaust gas is permitted to bypass the secondary muffler and flow from the primary muffler to the idle relief outlet and into a closed position wherein the exhaust gas is not permitted to bypass the secondary muffler and instead flows from the primary muffler to the idle relief outlet via the secondary muffler.

U.S. Pat. No. 10,724,410 discloses a marine propulsion device including an internal combustion engine powering the marine propulsion device and an engine compartment containing the engine. A primary exhaust passageway routes exhaust gas away from the engine and out of the engine compartment. A sound enhancement assembly communicates with the primary exhaust passageway. The sound enhancement assembly includes a sound enhancement device tuned to amplify exhaust sounds of a predetermined frequency and a sound duct downstream of the sound enhancement device that transmits the amplified exhaust sounds to an area outside the engine compartment. The sound enhancement device isolates the sound duct from the exhaust gas. A method for modifying sounds produced by an exhaust system of the internal combustion engine is also disclosed.

Unpublished U.S. patent application Ser. No. 15/936,671, filed Mar. 27, 2018, discloses a marine drive having a primary exhaust outlet on its lower gearcase that discharges a primary flow of exhaust gas from the engine to seawater in which the marine drive is situated. A secondary exhaust outlet is located on the marine drive above the primary exhaust outlet and discharges a secondary flow of exhaust gas from the engine to atmosphere around the marine drive at least when the engine is operated at an idle speed. A tertiary exhaust outlet is located on the marine drive between the primary and secondary exhaust outlets, and discharges a tertiary flow of exhaust gas from the engine to the seawater or to the atmosphere depending upon a current location of the tertiary exhaust outlet with respect to the seawater. A muffler is configured to reduce noise emanating from the tertiary exhaust outlet.

Patents describing various joysticking, autopilot, stationkeeping, and waypoint tracking features and related system and methods include: U.S. Pat. Nos. 7,267,068; 7,305,928; 7,561,886; 8,050,630; 8,417,399; 8,694,248; 8,777,681; 8,807,059; 8,924,054; 9,039,468; 9,132,903; 9,248,898; 9,377,780; 9,733,645; and 9,927,520.

Each of the above patents and applications is hereby incorporated by reference herein.

SUMMARY

This Summary is provided to introduce a selection of concepts that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

A system for controlling exhaust flow from an internal combustion engine powering a marine propulsion device configured to propel a marine vessel in a body of water is described according to one example of the present disclosure. The system comprises a primary exhaust conduit having an upstream end configured to receive exhaust gas from the internal combustion engine and a downstream end configured to discharge the exhaust gas to the body of water via a gearcase housing of the marine propulsion device, wherein the exhaust gas is discharged from an aft end of the gearcase housing. A bypass exhaust conduit has an upstream end configured to receive the exhaust gas from the primary exhaust conduit and a downstream end configured to discharge the exhaust gas from a bypass outlet of the marine propulsion device. A bypass valve is selectively openable to allow the exhaust gas to flow through the bypass conduit. A control module is in signal communication with the bypass valve. The control module opens the bypass valve to divert the exhaust gas through the bypass conduit and out the bypass outlet in response to selection of a control mode of the marine propulsion device other than a default lever control mode.

According to another example of the present disclosure, a method is disclosed for controlling flow of exhaust gas from an internal combustion engine powering a marine propulsion

device configured to propel a marine vessel in a body of water. The method is carried out by a control module and comprises determining if the marine propulsion device is being operated in a control mode other than a default lever control mode, and determining if a transmission of the marine propulsion device is in reverse gear. In response to the marine propulsion device being operated in the control mode other than the default lever control mode and the transmission being in reverse gear, the method includes opening a bypass valve to direct a bypass flow of the exhaust gas through a bypass exhaust passageway for discharge from a bypass outlet of the marine propulsion device. The bypass exhaust passageway is configured to receive the bypass flow of the exhaust gas from a primary exhaust passageway when the bypass valve is open, and the primary exhaust passageway is configured to receive a primary flow of the exhaust gas from the internal combustion engine and to discharge the primary flow of the exhaust gas to the body of water via a gearcase housing of the marine propulsion device. The primary flow of the exhaust gas is discharged from an aft end of the gearcase housing, and the bypass outlet is located remote from the aft end of the gearcase housing.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is described with reference to the following Figures. The same numbers are used throughout the Figures to reference like features and like components.

FIG. **1** illustrates one example of a marine vessel having a marine propulsion system including a marine propulsion device.

FIGS. **2** and **3** illustrate a schematic example of an exhaust system for the marine propulsion device of FIG. **1**.

FIG. **4** illustrates one example of a marine propulsion device that could be used on the marine vessel of FIG. **1**.

FIG. **5** illustrates a detailed view of a portion of the marine propulsion device of FIG. **4**.

FIG. **6** illustrates a cross-sectional view of a portion of FIG. **5**.

FIG. **7** illustrates one example of a method for controlling flow of exhaust gas from an internal combustion engine powering a marine propulsion device according to the present disclosure.

DETAILED DESCRIPTION

In the present description, certain terms have been used for brevity, clarity, and understanding. No unnecessary limitations are to be inferred therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes only and are intended to be broadly construed.

FIG. **1** illustrates an example of a marine vessel **10** and its marine propulsion system **12**, including an electronic navigation device **14** and a control module **16** in signal communication with the electronic navigation device **14**. The electronic navigation device **14** comprises a display screen **18** and a user input device **20**. The user input device **20** could be one or more of a touch-sensitive display screen (which can be the same as the display screen **18**), a keyboard, a keypad, a mouse, a track ball, a button or buttons, a stylus, a smart device such as a smart phone or a tablet, a remote control, a voice recognition module, etc. The electronic navigation device **14** can, for instance, be a chart plotter or a combined fish finder and chart plotter. Other electronic navigational devices provided with GPS capabilities or other location determination capabilities may be used.

The control module **16** controls a marine propulsion device **22**, including an internal combustion engine **24**, transmission **26**, steering actuator **28**, trim actuator **30**, and propeller **32**. Two or more propulsion devices, which may each have the components listed hereinabove, may instead be provided. The propulsion device(s) may be outboards, stern drives, pod drives, jet drives, and/or thrusters. The control module **16** is in signal communication via a communication link **34** with the electronic navigation device **14**, a steering wheel **38**, a throttle lever **40**, a joystick **42**, and a number of gauges **44**, located at or near a helm of the marine vessel **10**. Both the throttle lever **40** and the joystick **42** are operator input devices configured to provide throttle position (i.e., thrust) commands to a throttle valve **36** of the internal combustion engine **24** and shift commands to the transmission **26** via the control module **16**. A position determination device, such as a global positioning system (GPS) receiver **46**, is also provided as part of or in signal communication with the electronic navigation device **14**. Note that other types of position determination devices, such as a radio-based system or a DGPS system, could instead be provided. The marine vessel **10** also has a heading detector, such as an inertial measurement unit (IMU) **48**, in signal communication with the control module **16**. In other examples, a compass, gyro, or an attitude and heading reference system (AHRS) may be used for detecting the vessel's heading. A speed of the marine vessel **10** could be determined from a vessel speed sensor such as a pitot tube or a paddle wheel, or by using GPS position readings over time.

The control module **16** is programmable and includes a processing system and a storage system. The control module **16** can be located anywhere on the marine vessel **10** and/or located remote from the marine vessel **10** and can communicate with various components of the marine vessel **10** via peripheral interfaces and wired and/or wireless links, as will be explained further hereinbelow. Although FIG. **1** shows one control module **16**, the marine vessel **10** can include two or more control modules. Portions of the method disclosed herein below can be carried out by a single control module or by several separate control modules. For example, the system can have a control module located at or near the helm of the marine vessel **10** and can also have control module(s) located at or near each propulsion device. The electronic navigation device **14** can be programmed to perform some of the calculations described herein below, or the control module **16** can be programmed to perform certain calculations. The electronic navigation device **14** can provide commands to the control module **16** on its own initiative, or in response to a command from the control module **16**.

In some examples, the control module **16** may include a computing system that includes a processing system, storage system, software, and input/output (I/O) interface for communicating with peripheral devices. The systems may be implemented in hardware and/or software that carries out a programmed set of instructions. For example, the processing system loads and executes software from the storage system, such as software programmed with a vessel maneuvering method or a method for an exhaust system, which directs the processing system to operate as described hereinbelow in further detail. The computing system may include one or more processors, which may be communicatively connected. The processing system can comprise a microprocessor, including a control unit and a processing unit, and other circuitry, such as semiconductor hardware logic, that retrieves and executes software from the storage system. The processing system can be implemented within a single processing device but can also be distributed across multiple processing devices or sub-systems that cooperate according to existing program instructions. The processing system can include one or many software modules comprising sets of computer-executable instructions for carrying out various functions as described herein.

As used herein, the term "control module" may refer to, be part of, or include an application specific integrated circuit (ASIC); an electronic circuit; a combinational logic circuit; a field programmable gate array (FPGA); a processor (shared, dedicated, or group) that executes code; other suitable components that provide the described functionality; or a combination of some or all of the above, such as in a system-on-chip (SoC). A control module may include memory (shared, dedicated, or group) that stores code executed by the processing system. The term "code" may include software, firmware, and/or microcode, and may refer to programs, routines, functions, classes, and/or objects. The term "shared" means that some or all code from multiple modules may be executed using a single (shared) processor. In addition, some or all code from multiple control modules may be stored by a single (shared) memory. The term "group" means that some or all code from a single control module may be executed using a group of processors. In addition, some or all code from a single control module may be stored using a group of memories.

The storage system can comprise any storage media readable by the processing system and capable of storing software. The storage system can include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer-readable instructions, data structures, software modules, or other data. The storage system can be implemented as a single storage device or across multiple storage devices or sub-systems. The storage system can include additional elements, such as a memory controller capable of communicating with the processing system. Non-limiting examples of storage media include random access memory, read-only memory, magnetic discs, optical discs, flash memory, virtual and non-virtual memory, various types of magnetic storage devices, or any other medium which can be used to store the desired information and that may be accessed by an instruction execution system. The storage media can be a transitory storage media or a non-transitory storage media such as a non-transitory tangible computer readable medium.

The control module **16** communicates with one or more components on the marine vessel **10** via its **110** interface and the communication link **34**, which can be a wired or wireless link. In one example, the communication link **34** is a controller area network (CAN) bus, but other types of links could be used. Note that the connections shown herein by dotted lines are not the only connections that may exist between the various components on the marine vessel **10**, but rather are used for purposes of illustration.

As is known, the marine propulsion system **12** can be operated in a joysticking mode, in which the joystick **42** is used to input commands related to the desired magnitude and direction of thrust of the marine propulsion device **22**. For example, the handle of the joystick **42** can be moved in a forward, backward, right, or left direction in order to command the marine vessel **10** to move in a corresponding direction. Additionally, the handle of the joystick **42** can be moved in a diagonal direction, indicating that the marine vessel **10** is to move diagonally, rather than directly to the front, back, right, or left. The handle of the joystick **42** can also be rotated about its upright axis in order to command the marine vessel **10** to rotate (yaw). In order to place the marine propulsion system **12** in the joysticking mode, the operator may shift the throttle lever **40** into a neutral detent position before selecting a joysticking mode via the base of the joystick **42**, from the display screen **18**, or via the user input device **20**. Alternatively, the user need not select a joysticking mode after placing the throttle lever **40** in neutral, but may simply move the handle of the joystick **42** away from its neutral detent position or rotate the handle of joystick **42** about its axis in order to initiate the joysticking mode. The joysticking mode may be initiated in ways other than those described herein. Joysticking modes are well-known to those having ordinary skill in the art and are described in many of the above-incorporated patents, including U.S. Pat. No. 7,267,068, and therefore will not be described further herein below.

The marine propulsion system **12** may also be operated in a docking mode, in which the control module **16** automatically reduces any throttle position commands from an operator input device, such as the throttle lever **40** or the joystick **42**, by predetermined factor before sending the reduced throttle position commands to the throttle valve **36** on the internal combustion engine **24**. For example, the docking mode may be selected via the display screen **18** or the user input device **20**. It may be required that the throttle lever **40** is placed in a neutral detent position before the docking mode is selected, or other methods for initiating the docking mode may be provided. When the docking mode is enabled, the control module **16** may reduce any throttle commands from the throttle lever **40** by, for example, 50%, before sending the reduced throttle commands to the throttle valve **36**. When the docking mode is enabled and the operator is using the joystick **42**, the control module **16** may reduce any throttle commands from the joystick **42** by, for example, 70%, before sending the reduced throttle commands to the throttle valve **36**. In essence, in the docking mode, the marine propulsion device **22** produces less thrust than it would were it to be in a default (normal) control mode. This allows the operator to have more control over the incremental thrust via the throttle lever **40** or joystick **42**, given the same amount of movement thereof.

As is known, in a station-keeping mode, the marine vessel **10** can be maintained in a single global position (defined by latitude and longitude) and at a predetermined heading by way of an algorithm that controls the marine propulsion device **22** to counteract the effects of wind, waves, current, etc. that would tend to move the marine vessel **10** off this location and/or to a new heading. The station-keeping mode can be initiated by placing the throttle lever **40** into a neutral detent position and thereafter selecting a station-keeping mode option via the display screen **18** and/or user input device **20**. In some embodiments, the station-keeping mode will not be initiated until after the marine vessel's speed drops below a predetermined threshold. In the station-keeping mode, the marine propulsion device **22** is controlled to maintain the marine vessel **10** at a virtual anchor point. The control module **16** acts as a joystick and calculates left/right, fore/aft, and yaw commands required to drive the vessel's position error and heading error to zero by controlling thrust and angular orientation of the marine propulsion device **22**.

The control module **16** determines when and how much corrective action to take according to a three-dimensional (left/right, fore/aft, and yaw) proportional, integral, and derivative (PID) control algorithm performed by a feedback controller. The PID feedback controller computes a desired force in the forward/back and left/right directions with reference to the marine vessel **10**, along with a desired yaw moment relative to the marine vessel **10**, in order to null the error elements. The control module **16** then sends commands to steer the marine propulsion device **22**, control the power provided to the propeller **32**, and control the thrust vector direction of the marine propulsion device **22** (i.e., control the transmission **26** in forward or reverse) in order to deliver the requested forces and moments. Such automatic correction of the position and heading of the marine vessel **10** can be achieved according to the principles described in U.S. Pat. No. 7,305,928, which was incorporated by reference herein above.

The marine vessel **10** can also be controlled in a waypoint tracking mode. In the waypoint tracking mode, the marine vessel **10** is automatically guided to a waypoint (e.g., a global position defined in terms of latitude and longitude) or to several waypoints along a track. To initiate waypoint tracking mode, for example, the operator of the marine vessel **10** may first place the throttle lever **40** in a forward detent position, then select a point or a track **50** from a chart plotter (e.g., display screen **18**), and then select waypoint tracking mode from the chart plotter or from a separate autopilot controller. The control module **16** then obtains a commanded course according to the information provided by the chart plotter or autopilot controller. The control module **16** automatically guides the marine vessel **10** to each waypoint along the desired track **50** (or to the single selected waypoint) by providing steering and thrust commands to the marine propulsion device **22**. If the marine vessel **10** veers off this course, such as due to the effect of wind, waves, or the like, the control module **16** determines the corrective action needed to resume the commanded course so as to guide the marine vessel **10** back on track. The control module **16** provides steering and/or thrust commands to the marine propulsion device **22** to achieve such corrective action.

In the waypoint tracking mode, the control module **16** may use a course feedback signal (indicating an estimate of the course along which the marine vessel **10** is actually being propelled) to determine whether correction needs to be made to the actual course of the marine vessel **10** in order to maintain the commanded course along the desired track. The feedback controller of the control module **16** uses the course feedback signal to determine how and to what extent the marine propulsion device **22** must be steered (and/or provided with what thrust) in order to re-orient the marine vessel **10** to the commanded course, such as using a PID control algorithm as described hereinabove. Such measurement and automatic correction of the course of the marine vessel **10** can be achieved according to the principles described in U.S. Pat. No. 9,377,780, which was incorporated by reference above.

The marine propulsion system **12** may also be operated in an auto-docking mode, in which the marine vessel **10** is automatically guided to a position near a dock, seawall, or other object of interest. The auto-docking mode uses inputs from sensors, which can identify nearby objects, as well as inputs from the GPS receiver **46** and/or IMU **48**, in order to automatically control the thrust of the marine propulsion device **22** and direct the marine vessel **10** to a docked position while avoiding any obstacles between the marine vessel **10** and the object of interest. Auto-docking modes are described in U.S. Application Publication No. 2017/0253314; U.S. Application Publication No. 2018/0057132; U.S. Pat. Nos. 10,324,468; 10,429,845; and Unpublished U.S. application Ser. No. 15/986,395, filed May 22, 2018, each of which are hereby incorporated by reference in their entireties. In order to enable the auto-docking mode, the operator may shift the throttle lever **40** into a neutral detent position and then select the auto-docking mode from the display screen **18** or user input device **20**.

Referring now to FIGS. **2** and **3**, an exemplary exhaust system **52** for use with the internal combustion engine **24** is schematically depicted. The exhaust system **52** includes a primary exhaust conduit **54** having an upstream end **56** that is configured to receive hot, dry exhaust gas from the internal combustion engine **24** and a downstream end **58** that is configured to discharge the exhaust gas to a body of water **60** via a gearcase housing **62** of the marine propulsion device **22**. The manner in which the exhaust gas is discharged from the gearcase housing **62** can vary. In certain examples, the exhaust gas is discharged via a propeller housing outlet **64** that is located in the body of water **60** when the marine propulsion device **22** is in use. This is a conventional arrangement for discharging the exhaust gas from a marine propulsion device and thus the propeller housing outlet **64** is schematically shown and is not further described herein.

An bypass exhaust conduit **66** is coupled to the primary exhaust conduit **54** between the upstream end **56** and the downstream end **58** thereof. The bypass exhaust conduit **66** has an upstream end **65** that receives the exhaust gas from the primary exhaust conduit **54**. Optionally, a muffler (sometimes referred to as an "idle relief muffler") **68** receives the exhaust gas from a downstream end **67** of the bypass exhaust conduit **66** and discharges the exhaust gas to an idle relief outlet **70**, which typically is formed through a cowling of the marine propulsion device **22**. In other examples, the bypass exhaust conduit **66** discharges the exhaust gas to the idle relief outlet **70** without passing through a muffler. The idle relief outlet **70** is configured to discharge the exhaust gas to atmosphere. More specifically, the idle relief outlet **70** is configured to be located above the body of water **60** in which the marine propulsion device **22** is operating, at least when the internal combustion engine **24** of the marine propulsion device **22** is operated at an idle speed.

According to the present disclosure, a bypass valve **72** is coupled to and/or located in the bypass exhaust conduit **66** between the primary exhaust conduit **54** and the idle relief outlet **70**. The type of bypass valve **72** can vary and in certain examples can be a conventional mechanically-controlled valve and in other examples can be a conventional electrically-controlled valve. The bypass valve **72** is positionable into an open position, shown in FIG. **3**, wherein the exhaust gas is permitted to flow through the bypass exhaust conduit **66** from the primary exhaust conduit **54** to the muffler **68** and idle relief outlet **70**. Thus, in the open position, the exhaust gas is allowed to bypass the downstream end **58** of the primary exhaust conduit **54** and bypass the gearcase housing **62** and flow directly from the primary exhaust conduit **54** to the idle relief outlet **70** via the bypass exhaust conduit **66** and optionally via the muffler **68**. The bypass valve **72** is alternately positionable into a closed position, shown in FIG. **2**, wherein the exhaust gas is not permitted to flow through the bypass exhaust conduit **66** from the primary exhaust conduit **54**, and thus is not allowed to bypass the downstream end **58** of the primary exhaust conduit **54** and gearcase housing **62**. Instead, the exhaust gas is forced to flow to the gearcase housing **62** for subsequent discharge to the body of water **60** via the propeller housing outlet **64** and/or to atmosphere via the muffler **68** and idle relief outlet **70**, which are connected to the gearcase housing **62** by a secondary exhaust conduit **74**. The secondary exhaust conduit **74** has an upstream end **76** that is configured to receive the exhaust gas from the gearcase housing **62** and a downstream end **78** that is configured to discharge the exhaust gas to the muffler **68**, for subsequent discharge via the idle relief outlet **70**.

In some examples, the bypass valve **72** can be positionable into one or more intermediate position(s) wherein, as compared to the noted open position shown in FIG. **3**, a reduced amount of the exhaust gas is permitted to bypass the downstream end **58** of the primary exhaust conduit **54** and gearcase housing **62**. In other words, when the bypass valve **72** is in the intermediate position(s), some of the exhaust gas is allowed to bypass the downstream end **58** of the primary exhaust conduit **54** and bypass the gearcase housing **62** and flow directly from the primary exhaust conduit **54** to the idle relief outlet **70** via the bypass exhaust conduit **66** and optionally the muffler **68**. The remainder of the exhaust gas is forced to flow to the gearcase housing **62** for subsequent discharge to the body of water **60** via the propeller housing outlet **64** and/or to atmosphere via the muffler **68** and idle relief outlet **70**, which are connected to the gearcase housing **62** by the secondary exhaust conduit **74**.

In some examples, the exhaust system **52** can include an operator input device **80** that is mechanically and/or electrically and/or otherwise communicatively coupled to and configured to control the bypass valve **72**. The operator input device **80** can be configured such that, via the operator input device **80**, an operator has the ability to selectively position the bypass valve **72** into and out of the open and closed positions, and optionally the intermediate position(s). The type and configuration of the operator input device **80** can vary, and the manner in which the operator input device **80** is connected to the bypass valve **72** can vary. In certain non-limiting examples, the operator input device **80** can include one or more mechanical levers, computer keypads, slider bars, touch screens, and/or the like. The operator input device **80** can be configured to directly communicate with and control the position of the bypass valve **72** via, for example, a mechanical or electronically wired or wireless communication link, an example of which is schematically shown in the drawings. In other examples, the operator input device **80** can be configured to communicate an operator input to the control module **16**, which can be configured to electronically control the bypass valve **72**.

Optionally, the exhaust system **52** can include an indicator device **82** that is configured to indicate to the operator a current position of the bypass valve **72**. The operator input device **80** and/or indicator device **82** can be located, for example, at the helm of the marine vessel **10**. The type of indicator device **82** can vary. In certain non-limiting examples, the indicator device **82** can be one of the gauges **44**, or can include a video or touch screen (e.g., display screen **18**), flashing lights, and/or the like. The indicator device **82** can be electronically controlled by the control module **16** to indicate to the operator the current position of the bypass valve **72**.

FIGS. **4-6** depict portions of one example of the marine propulsion device **22**, including an example of a muffler for a tertiary flow of exhaust gas. As noted herein above, the marine propulsion device **22** is powered by the internal combustion engine **24** (shown schematically) that causes rotation of a generally vertically extending driveshaft **84**. The driveshaft **84** extends from the internal combustion engine **24** into a driveshaft housing **86** located below the internal combustion engine **24**. A lower gearcase housing **88** is located below the driveshaft housing **86** and contains a transmission gearset **90** (shown schematically) that operably connects the driveshaft **84** to a generally horizontally extending propeller shaft **92**. The propeller shaft **92** laterally extends from the gearcase housing **88** and supports the propeller **32** such that rotation of the propeller shaft **92** causes rotation of the propeller **32**. Thus, operation of the internal combustion engine **24** causes rotation of the driveshaft **84**, which in turn causes rotation of the propeller shaft **92** and propeller **32**, as is conventional. The transmission gearset **90** can be actuated by a conventional shift actuator (not shown) to control the rotational direction of the propeller shaft **92** and propeller **32** in either forward, neutral, or reverse gears, as is conventional.

As shown in FIG. **4**, the marine propulsion device **22** has a primary exhaust outlet **94** from the gearcase housing **88** via a hub **96** of propeller **32**. The primary exhaust outlet **94** discharges a primary flow of exhaust gas from the internal combustion engine **24** directly to the water in which the marine propulsion device **22** is situated. In the presently illustrated example, the primary exhaust outlet **94** receives the primary flow of exhaust gas from a primary exhaust conduit **98** that extends from an upstream end **114** coupled to the internal combustion engine **24** and vertically downwardly alongside the driveshaft housing **86**. In other examples, the primary exhaust conduit **98** is located internally of the driveshaft housing **86**. The primary flow of exhaust gas is communicated from a downstream end **116** of the primary exhaust conduit **98** to the gearcase housing **88** and then to the primary exhaust outlet **94** via the hub **96** of the propeller **32**.

The marine propulsion device **22** also has an idle relief system **122** including a secondary exhaust outlet **100** located on the marine propulsion device **22** above the primary exhaust outlet **94**, generally located near the top of the driveshaft housing **86**. The secondary exhaust outlet **100** discharges a secondary flow of exhaust gas from the internal combustion engine **24** at least when the internal combustion engine **24** is operated at idle speeds. The secondary exhaust outlet **100** remains above water during all operational states of the marine propulsion device **22**. The secondary exhaust outlet **100** receives the secondary flow of exhaust gas from an opening **102** in the primary exhaust conduit **98**, wherein the secondary flow of exhaust gas flows to an idle relief muffler **104**, and from the idle relief muffler **104** to the atmosphere via an idle relief grommet **106**.

The marine propulsion device **22** also has a tertiary exhaust outlet **108** located on the marine propulsion device **22** vertically between the primary and secondary exhaust outlets **94**, **100**. In the illustrated example, the tertiary exhaust outlet **108** is located proximate to the union between the driveshaft housing **86** and gearcase housing **88** and adjacent to a cavitation plate **110** on the gearcase housing **88**; however, the location can vary from what is shown. The tertiary exhaust outlet **108** discharges a tertiary flow of exhaust gas from the internal combustion engine **24** to the water or to the atmosphere depending on a current location of the tertiary exhaust outlet **108** with respect to the water, as the marine propulsion device **22** changes position in the water deepening on the tilt and trim thereof and the position of the marine vessel **10** with respect to the surface of the water, which may depend on vessel speed.

Referring to FIGS. **5** and **6**, a muffler **124** for controlling exhaust noise associated with the tertiary exhaust outlet **108** is described. The muffler **124** is located between the driveshaft housing **86** and the gearcase housing **88**, and is partially disposed in the gearcase housing **88**, as shown in FIG. **6**. The muffler **124** has an expansion chamber **126** that promotes expansion of the tertiary flow of exhaust gas therein and also provides a pathway for the primary flow of exhaust gas to flow therethrough. The muffler **124** further has port and starboard wings **128** that laterally extend from port and starboard sides of the expansion chamber **126** and are sandwiched between the driveshaft housing **86** and gearcase housing **88**. Port and starboard aftwardly-oriented outlet channels **112** are formed in the port and starboard wings **128**, respectively, and are configured to discharge the tertiary flow of exhaust gas from the expansion chamber **126**.

The tertiary flow of exhaust gas follows a tortuous path from the expansion chamber **126** to the tertiary exhaust outlet **108**. Specifically, the expansion chamber **126** has inner sidewalls **130** and outer sidewalls **132**. Port and starboard passageways **134** vertically extend between the inner and outer sidewalls **130**, **132** and are connected to the port and starboard outlet channels **112**, respectively. Thus, the primary flow of exhaust gas is conveyed downwardly through and past the expansion chamber **126** and to the gearcase housing **88** for discharge via the primary exhaust outlet **94** through the propeller hub **96**. The tertiary flow of exhaust gas is a portion the primary flow of exhaust gas that separates from the primary flow of exhaust gas and flows upwardly through the port and starboard passageways **134** (as shown by the arrows **136**) and then aftwardly through the port and starboard outlet channels **112** for discharge from the marine propulsion device **22**. Thus, the port and starboard passageways **134** act as bypass exhaust conduits having upstream ends **138** configured to receive exhaust gas from the primary exhaust conduit **98** (via expansion chamber **126**) and downstream ends **140** configured to discharge the exhaust gas from bypass outlets (outlet channels **112**) of the marine propulsion device **22**. Each bypass exhaust conduit **134** is provided with a bypass valve **144** therein, which is communicatively connected to the control module **16**, for purposes that will be described herein below.

During research and development, the present inventors realized that while operating in certain modes, specifically those modes in which the marine propulsion device **22** is likely to be required to produce a reverse thrust, it may be desirable to have less exhaust exiting from the gearcase housing **62**, **88**. Reducing the amount of exhaust gas that is pulled through the propeller **32** allows for increased reverse thrust authority while operating in these modes. Although some exhaust may still exit from the gearcase housing **62**, **88**, in general, by diverting at least a portion of the exhaust gas through a bypass outlet located other than near the propeller **32**, the propeller **32** is able to get better bite in the water when operating in reverse. Additionally, the present inventors have realized that bypassing exhaust gas through a bypass conduit and outlet only when increased reverse thrust authority is required, or only when the transmission **26** is in reverse, reduces noise from the marine propulsion device **22** as opposed to if the bypass valve(s) were always open.

Therefore, the present disclosure is of a system for controlling exhaust flow from an internal combustion engine **24** powering a marine propulsion device **22** configured to propel a marine vessel **10** in a body of water **60**. The system includes a primary exhaust conduit **54**, **98** having an upstream end **56**, **114** configured to receive exhaust gas from the internal combustion engine **24** and a downstream end **58**, **116** configured to discharge the exhaust gas to the body of water **60** via the gearcase housing **62**, **88** of the marine propulsion device **22**. The exhaust gas is discharged from an aft end of the gearcase housing **62**, **88**, such as through the propeller housing outlet **64** or primary exhaust outlet **94**.

The system also includes a bypass exhaust conduit **66**, **134** having an upstream end **65**, **138** configured to receive the exhaust gas from the primary exhaust conduit **54**, **98** and a downstream end **67**, **140** configured to discharge the exhaust gas from a bypass outlet of the marine propulsion device **22**. For example, the bypass outlet can be the idle relief outlet **70** (FIGS. **2** and **3**) or the outlet channels **112** (FIGS. **5** and **6**). As noted hereinabove, a muffler **68** need not be provided in the embodiments of FIGS. **2** and **3**, and the downstream end **67** of the bypass exhaust conduit **66** may be connected directly to the bypass outlet. In one example, the downstream end **67** of the bypass exhaust conduit **66** is the bypass outlet itself.

In order to provide for selective flow of the exhaust gas through the bypass exhaust conduit **66**, **134**, a bypass valve, which is selectively openable to allow the exhaust gas to flow through the bypass exhaust conduit **66**, **134**, may be provided. In the example of FIGS. **2** and **3**, the bypass valve is shown schematically at **72**. In the example of FIG. **6**, two bypass valves **144** are schematically shown situated within the bypass exhaust conduits **134**.

As noted, the bypass valve(s) **72**, **144** is/are in signal communication with the control module **16**. According to the method of the present disclosure, the control module **16** opens the bypass valve(s) **72**, **144** to divert the exhaust gas through the bypass exhaust conduit **66**, **134** and out the bypass outlet **70**, **112** in response to selection of a control mode of the marine propulsion device **22** other than a default lever control mode. Note that in the example of FIGS. **4-6**, a bypass conduit, bypass valve, and bypass outlet like that shown in FIGS. **2** and **3** could be provided with the idle relief system **122**. Bypass valves could be provided solely in the bypass exhaust conduits **134**, or in both the bypass exhaust conduits **134** and the bypass exhaust conduit associated with the idle relief system **122**. The control module **16** could selectively open whichever bypass valve(s) was/were provided according to the algorithm described more fully herein below.

In the default lever control mode, as is known, the operator uses the throttle lever **40** and steering wheel **38** to provide shift/thrust and steering commands, respectively, to the marine propulsion device **22**. For example, the operator can move the throttle lever **40** into the neutral detent position in order to stop providing thrust to the marine vessel **10**; into a forward gear position in order to propel the marine vessel **10** in a forward direction while steering with the steering wheel **38**; or into a reverse gear position in order to propel the marine vessel **10** in a backwards direction while steering with the steering wheel **38**.

In one example, the control mode other than the default lever control mode is any control mode in which the operator does not control shift and throttle solely with the throttle lever **40**. For example, the control mode may be one in which the control module **16** automatically commands the marine propulsion device **22** to produce thrust intended to cause the marine vessel **10** to achieve a predefined objective. The predefined objective may be to remain electronically anchored at a given latitude and longitude (station-keeping mode), to travel along a predefined track (waypoint tracking mode), or to automatically propel the marine vessel **10** to an object of interest and thereafter maintain the marine vessel **10** in proximity to that object (auto-docking mode). In such a control mode in which the marine vessel **10** is to achieve a predefined objective, the control module **16** may open the bypass valve **72**, **144** in response to an additional determination that a reverse thrust commanded by the control module **16** is insufficient to cause the marine vessel **10** to achieve the predefined objective. In other words, if the control module **16** calculates that the marine propulsion device **22** needs to provide a reverse thrust of a certain value to achieve a desired position or heading, but feedback from the GPS receiver **46** or IMU **48** indicates that the marine vessel **10** is not able to achieve the desired position or heading with such reverse thrust, the control module **16** may determine that additional reverse thrust authority is required. The control module **16** will therefore open the bypass valve **72**, **144** in order to divert some of the exhaust gas away from the primary exhaust pathway, and therefore away from being discharged from the rear of the gearcase housing **62**, **88**.

In another example, even before the control module **16** determines that the reverse thrust it calculates as being required in order to achieve the predefined objective is not enough to achieve such objective, the operator may select an operator-selectable input configured to enable high-sensitivity of the control mode. The operator-selectable input may be a button or selection available via the display screen **18** or the user input device **20**. The control module **16** may open the bypass valve in response to an additional determination that high-sensitivity of the control mode is enabled. In other words, if the operator knows that the marine vessel **10** is operating in high wind or fast current conditions, the operator may choose to enable high-sensitivity of the high station-keeping, waypoint tracking, or auto-docking mode in order to automatically provide increased reverse thrust authority to the marine propulsion device **22**, assuming such increased authority will be required to counteract the external conditions acting on the marine vessel **10**.

In another example, the control mode other than the default lever control mode is one in which the control module **16** does not receive the shift or thrust commands from the throttle lever **40**. For example, the control mode may be the joysticking mode, in which shift and thrust commands are mapped from a position of the joystick **42**.

In another example, the control mode is one in which the control module **16** automatically reduces the throttle position commands from an operator input device configured to provide throttle position commands to the throttle valve **36** of the internal combustion engine **24** via the control module **16** by a predetermined factor before sending the reduced throttle position commands to the throttle valve **36**. For example, the control mode could be the docking mode, in which the operator has requested that throttle commands from the throttle lever **40** or joystick **42** be reduced in order to provide more precision to the level of throttle control.

In any of the above examples, the control module **16** may open the bypass valve **72**, **144** in response to an additional determination that the transmission **26** of the marine propulsion device **22** is in reverse gear. The control module **16** may make this determination based on a reading from a gear position sensor or based on the commanded gear position the control module **16** sent to the transmission **26**. In such a manner, the control module **16** may control bypass flow of the exhaust gas such that the bypass flow occurs only when the marine propulsion device **22** is actually operating in reverse gear, and thus increased reverse thrust authority may be necessary.

In another example, the control module **16** opens the bypass valve **72**, **144** in response to an additional determination that external environmental conditions are acting on the marine vessel **10** in a direction opposite that of a reverse thrust of the marine propulsion device **22**. For example, the control module **16** may be provided in signal communication with a wind sensor or current sensor, which may provide the control module **16** with information regarding whether external conditions are calm or rough. If external conditions are relatively rough and are acting in a direction opposite that of the reverse thrust commanded from the marine propulsion device **22**, the control module **16** may open the bypass valve **72**, **144** in order to provide increased reverse thrust authority. Whether a certain wind speed or current speed would be considered enough that increased reverse thrust authority was required could be calibrated into the vessel's personality and based on vessel size and/or weight. Note that the direction of the external disturbance on the marine vessel **10** need not be one that acts in an aft-to-fore direction of the marine vessel **10**, but could be an external force that acts opposite the direction of reverse thrust of the marine propulsion device **22** taking a steering angle thereof into account.

In all of the above examples, the bypass valve **72**, **144** may be configured to be incrementally opened and closed, or to be fully opened or fully closed. For example, in response to the above-noted conditions being met, the control module **16** may fully open the bypass valve **72**, **144**, and in response to the above-noted conditions not being met, the control module **16** may fully close the bypass valve **72**, **144**. In other examples, in response to determining that the above-noted conditions are met, the control module **16** may incrementally open the bypass valve **72**, **144** at a fixed ramp-in rate, which may be calibrated. In response to determining that the above-noted conditions are not met, the control module **16** may fully close the bypass valve **72**, **144** or may incrementally close the bypass valve **72**, **144** at a fixed ramp-out rate, which may be calibrated. In still other examples, incremental opening and closing of the bypass valve can be used in order to provide different levels of reverse thrust authority. For example, the bypass valve **72**, **144** can be opened to a position that is less than fully open if it is determined that a small amount of increased reverse thrust authority is required. If feedback indicates that more reverse thrust authority is in fact required, the bypass valve **72**, **144** can be opened even more. In another example, a button, slider bar, or similar user input device (see operator input device **80**, FIG. **2**) could be provided at the helm, such as on the display screen **18** or at the user input device **20**, that allows the operator to feather in the increased reverse thrust authority. For example, if the operator knows that environmental conditions are somewhat transient, the operator may choose to open the bypass valve **72**, **144** to a less than fully open position. On the other hand, if the operator knows that the marine vessel **10** is operating in very rough waters, the operator may choose to open the bypass valve **72**, **144** to a more open or fully open position.

While some of the examples shown and described hereinabove show the bypass conduit and the bypass outlet being in fluid condition with the idle relief system of the marine propulsion device **22**, note that this is not necessary, as in the example of bypass valves **144** provided in bypass exhaust conduits **134** (FIG. **6**). Furthermore, a completely separate bypass conduit and outlet could be provided on the marine propulsion device **22**. Note that the bypass conduit and bypass outlet could be provided at locations other than those shown herein. The bypass outlet can be located above or below the water level when the marine propulsion device **22** is operating at idle. In general, the bypass outlet will be located remote from the aft end of the gearcase housing **62**, **88** so that exhaust gas emitted therefrom not affect the bite of the propeller **32**. In one example, when the marine propulsion device **22** is a stern drive, the bypass conduit could divert exhaust gas through the back of the transom of the marine vessel **10**, rather than diverting it from the gearcase housing.

Now turning to FIG. **7**, a method for controlling flow of exhaust gas from an internal combustion engine **24** powering marine propulsion device **22** configured to propel a marine vessel **10** in a body of water **60** will be described. The method is carried out by control module **16** and includes, as shown at **700**, determining if marine propulsion device **22** is being operated in a control mode other than a default lever control mode. If yes, the control module **16** next determines if a transmission **26** of the marine propulsion device **22** is in reverse gear, as shown at **702**. If yes, in response to the marine propulsion device **22** being operated in the control mode other than the default lever control mode and the transmission **26** being in reverse gear, the control module opens the bypass valve **72**, **144** to direct a bypass flow of the exhaust gas through a bypass exhaust passageway **66**, **134** for discharge from a bypass outlet **70**, **112** of the marine propulsion device **22**, as shown at **704**. As noted herein above, the bypass exhaust passageway **66**, **134** is configured to receive the bypass flow of the exhaust gas from the primary exhaust passageway **54**, **98** when the bypass valve **72**, **144** is open. The primary exhaust passageway **54**, **98** is configured to receive a primary flow of the exhaust gas from the internal combustion engine **24** and to discharge the primary flow of the exhaust gas to the body of water **60** via a gearcase housing **62**, **88** of the marine propulsion device **22**. The primary flow of the exhaust gas is discharged from an aft end of the gearcase housing **62**, **88**, and the bypass outlet **70**, **112** is located remote from the aft end of the gearcase housing **62**, **88**.

If no at either of the determinations made at **700** or **702**, the control module **16** closes the bypass valve **72**, **144** (or maintains the bypass valve **72**, **144** in a closed position) to direct exhaust gas through the primary exhaust passageway **54**, **98** for discharge from the gearcase housing **62**, **88**. See **706**.

By implementing the above method on a marine propulsion device **22** provided with a bypass exhaust conduit/passageway, the marine propulsion device **22** is able to provide increased reverse thrust authority when necessary. As noted hereinabove, such reverse thrust authority may be increased when the marine propulsion device **22** is operated in a control mode other than a default lever control mode, such as in a station-keeping, waypoint tracking, joysticking, auto-docking, or docking mode. The increased reverse thrust authority may additionally or alternatively be provided when the control module **16** determines that reverse thrust actually being produced is insufficient to cause the marine vessel **10** to achieve a predefined position and/or heading or when high-sensitivity of the control mode is enabled by the operator. In other examples, the control module **16** may open the bypass valve in response to a determination that the operator or control module **16** is demanding an engine speed or a vessel speed above a predetermined threshold speed in a reverse direction. Such an embodiment might be provided even when the marine propulsion device **22** is operating in the default lever control mode.

In the above description, certain terms have been used for brevity, clarity, and understanding. No unnecessary limitations are to be inferred therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes and are intended to be broadly construed. The different systems and method steps described herein may be used alone or in combination with other systems and methods. It is to be expected that various equivalents, alternatives and modifications are possible within the scope of the appended claims. Each limitation in the appended claims is intended to invoke interpretation under 35 U.S.C. § 112(f), only if the terms "means for" or "step for" are explicitly recited in the respective limitation.

What is claimed is:

1. A system for controlling exhaust flow from an internal combustion engine powering a marine propulsion device configured to propel a marine vessel in a body of water, the system comprising:

a primary exhaust conduit having an upstream end configured to receive exhaust gas from the internal combustion engine and a downstream end configured to discharge the exhaust gas to the body of water via a gearcase housing of the marine propulsion device, wherein the exhaust gas is discharged from an aft end of the gearcase housing;

a bypass exhaust conduit having an upstream end configured to receive the exhaust gas from the primary exhaust conduit and a downstream end configured to discharge the exhaust gas from a bypass outlet of the marine propulsion device;

a bypass valve selectively openable to allow the exhaust gas to flow through the bypass exhaust conduit;

a control module in signal communication with the bypass valve; and

an operator input device configured to provide throttle position commands to a throttle valve of the internal combustion engine via the control module;

wherein the control module opens the bypass valve to divert the exhaust gas through the bypass exhaust conduit and out the bypass outlet in response to selection of a control mode of the marine propulsion device other than a default lever control mode; and

wherein the control mode is one in which the control module automatically reduces the throttle position commands from the operator input device by a predetermined factor before sending the reduced throttle position commands to the throttle valve.

2. The system of claim **1**, wherein the control module opens the bypass valve in response to an additional determination that a transmission of the marine propulsion device is in reverse gear.

3. The system of claim **1**, wherein the control module opens the bypass valve in response to an additional determination that external environmental conditions are acting on the marine vessel in a direction opposite that of a reverse thrust of the marine propulsion device.

4. The system of claim **1**, wherein the bypass valve is configured to be incrementally opened and closed.

5. The system of claim **1**, wherein the bypass exhaust conduit and the bypass outlet are in fluid communication with an idle relief system of the marine propulsion device.

6. The system of claim **1**, wherein the bypass outlet is located remote from the aft end of the gearcase housing.

7. A method for controlling flow of exhaust gas from an internal combustion engine powering a marine propulsion device configured to propel a marine vessel in a body of water, the method being carried out by a control module and comprising:

determining if the marine propulsion device is being operated in a control mode other than a default lever control mode;

determining if a transmission of the marine propulsion device is in reverse gear; and

in response to the marine propulsion device being operated in the control mode other than the default lever control mode and the transmission being in reverse gear, opening a bypass valve to direct a bypass flow of the exhaust gas through a bypass exhaust passageway for discharge from a bypass outlet of the marine propulsion device;

wherein the bypass exhaust passageway is configured to receive the bypass flow of the exhaust gas from a primary exhaust passageway when the bypass valve is open, and the primary exhaust passageway is configured to receive a primary flow of the exhaust gas from the internal combustion engine and to discharge the primary flow of the exhaust gas to the body of water via a gearcase housing of the marine propulsion device;

wherein the primary flow of the exhaust gas is discharged from an aft end of the gearcase housing, and the bypass outlet is located remote from the aft end of the gearcase housing;

wherein an operator input device is configured to provide throttle position commands to a throttle valve of the internal combustion engine via the control module; and

wherein the control mode is one in which the control module automatically reduces the throttle position commands from the operator input device by a predetermined factor before sending the reduced throttle position commands to the throttle valve.

8. The method of claim **7**, further comprising opening the bypass valve in response to an additional determination that external environmental conditions are acting on the marine vessel in a direction opposite that of a reverse thrust of the marine propulsion device.

9. The method of claim **7**, further comprising incrementally opening or closing the bypass valve.

10. The method of claim **7**, wherein the bypass exhaust passageway and the bypass outlet are in fluid communication with an idle relief system of the marine propulsion device.

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